Exemption No. 9949

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98057-3356

In the matter of the petition of **THE BOEING COMPANY** for an exemption from §§ 25.301, 25.303, 25.305, 25.307, 25.601, 25.603, 25.613, 25.901(b)(2) and (c), 25.1103(d), 25.1191, and 25.1301(d) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2009-0320**

PARTIAL GRANT OF EXEMPTION

By letters dated March 31, 2009, and May 12, 2009, J. B. Zundell, Lead Project Administrator, Production and Retrofit Projects, The Boeing Company, petitioned the Federal Aviation Administration (FAA) on behalf of The Boeing Company, P.O. Box 3707, M/C 67-LR, Seattle, Washington 98124-2207, for a time-limited exemption. The proposed exemption seeks relief from §§ 25.301, 25.303, 25.305, 25.307, 25.601, 25.603, 25.613, 25.901(b)(2) and (c), 25.1103(d), 25.1191, and 25.1301(d) of Title 14, Code of Federal Regulations (14 CFR), as they relate to two separate areas of thermal damage observed in service on the thrust reverser inner walls of Boeing Model 777-200 and -300 series airplanes powered by Rolls-Royce RB211 Trent 800 series turbofan engines. An independent cause for each of these areas of thermal damage has been identified. The proposed exemption, if granted, would permit type certification of non-compliant design improvements intended to mitigate the existing unsafe conditions associated with the thrust reverser inner wall thermal damage. It would allow a series of planned improvements to be implemented as they become available and collectively bring the affected airplanes back into full compliance.

In evaluating the petition for exemption, compliance with §§ 25.901(c) and 25.1103(d) as they relate to a pneumatic duct failure at high altitude and low airplane speed came into question. To expedite the previously mentioned design improvements, Boeing requested in its letter, dated

May 12, 2009, that this pneumatic duct failure issue also be covered by this exemption, since it will take at least six months to complete the analysis necessary to determine whether the airplane type design complies with the regulations.

The petitioner requires relief from the following regulations:

Section 25.301 Loads, which requires:

"(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the airplane. These loads must be distributed to conservatively approximate or closely represent actual conditions. Methods used to determine load intensities and distribution must be validated by flight load measurement unless the methods used for determining those loading conditions are shown to be reliable.

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account."

Section 25.303 Factor of safety, which requires:

"Unless otherwise specified, a factor of safety of 1.5 must be applied to the prescribed limit load which are considered external loads on the structure. When a loading condition is prescribed in terms of ultimate loads, a factor of safety need not be applied unless otherwise specified."

Section 25.305 Strength and deformation, which requires:

"(a) The structure must be able to support limit loads without any detrimental permanent deformation. At any load up to limit loads the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least 3 seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the 3-second limit does not apply. Static tests conducted to ultimate load must include the ultimate deflections and ultimate deformation induced by the loading. When analytical methods are used to show compliance with the ultimate load strength requirements, it must be shown that—

(1) The effects of deformation are not significant;

(2) The deformations involved are fully accounted for in the analysis; or

(3) The methods and assumptions used are sufficient to cover the effects of these deformations.

(c) Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application must be considered.

(d) [Reserved.]

(e) The airplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D, including stall and probable inadvertent excursions beyond the boundaries of the buffet onset envelope. This must be shown by analysis, flight tests, or other tests found necessary by the Administrator.

(f) Unless shown to be extremely improbable, the airplane must be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system. These must be considered limit loads and must be investigated at airspeeds up to V_C/M_C."

Section 25.307 Proof of structure, which requires:

"(a) Compliance with the strength and deformation requirements of this subpart must be shown for each critical loading condition. Structural analysis may be used only if the structure conforms to those for which experience has shown this method to be reliable. The Administrator may require ultimate load tests in cases where limit load tests may be inadequate.

(b)—(c) [Reserved]

(d) When static or dynamic tests are used to show compliance with the requirements of Sec. 25.305(b) for flight structures, appropriate material correction factors must be applied to the test results, unless the structure, or part thereof, being tested has features such that a number of elements contribute to the total strength of the structure and the failure of one element results in the redistribution of the load through alternate load paths."

Section 25.601 General, which requires:

"The airplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests."

Section 25.603 Materials, which requires:

"The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must—

(a) Be established on the basis of experience or tests;

(b) Conform to approved specifications (such as industry or military specifications, or Technical Standard Orders) that ensure their having the strength and other properties assumed in the design data ;and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service."

Section 25.613 Material strength properties and material design values, at Amendment 25-72, which requires:

"(a) Material strength properties must be based on enough tests of material meeting approved specifications to establish design values on a statistical basis.

(b) Design values must be chosen to minimize the probability of structural failures due to material variability. Except as provided in paragraph (e) of this section, compliance with this paragraph must be shown by selecting design values which assure material strength with the following probability:

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99 percent probability with 95 percent confidence.

(2) For redundant structure, in which the failure of individual elements would result in applied loads being safely distributed to other load carrying members, 90 percent probability with 95 percent confidence.

(c) The effects of temperature on allowable stresses used for design in an essential component or structure must be considered where thermal effects are significant under normal operating conditions.

(d) The strength, detail design, and fabrication of the structure must minimize the probability of disastrous fatigue failure, particularly at points of stress concentration.

(e) Greater design values may be used if a 'premium selection' of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

Section 25.901(b)(2) Installation, which requires:

"The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls"

Section 25.901(c) Installation, which requires:

"For each powerplant and auxiliary power unit installation, it must be established that no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the airplane except that the failure of structural elements need not be considered if the probability of such failure is extremely remote."

Section 25.1103(d) Induction system ducts and air duct systems, which requires:

"For turbine engine and auxiliary power unit bleed air duct systems, no hazard may result if a duct failure occurs at any point between the air duct source and the airplane unit served by the air."

Section 25.1191 Firewalls, which requires:

"(a) Each engine, auxiliary power unit, fuel-burning heater, other combustion equipment intended for operation in flight, and the combustion, turbine, and tailpipe sections of turbine engines, must be isolated from the rest of the airplane by firewalls, shrouds, or equivalent means.

(b) Each firewall and shroud must be—

(1) Fireproof;

(2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the airplane;

(3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings; and

(4) Protected against corrosion."

Section 25.1301(d) Function and installation, at Amendment 25-123, which requires that each item of installed equipment must:

"Function properly when installed."

The petitioner supports its request with the following information[1]:

"The Model 777 Rolls Royce thrust reverser inner wall has experienced structural failures, some of which have resulted in parts departing the airplane. The root cause of the failures has been determined to be thermal damage to the composite honeycomb sandwich inner wall structure. Two separate, independent causes for thermal damage have been identified: hot air ingress behind the thermal blankets, which protect the inner wall from the engine core compartment environment, and engine intermediate pressure compressor 8th stage (IP8) stability bleed exhaust air impingement on the fan air flow side of the thrust reverser inner fan duct wall."

To begin addressing these unsafe conditions as quickly as possible, Boeing seeks an exemption sufficient to allow implementation of thrust reverser and engine design improvements to Rolls-Royce-powered Model 777 airplanes (through Line Number 796), in any order and combination for up to six years from the date of granting. The design improvement packages currently identified include:

- Improved thrust reverser inner wall thermal protection system. This change incorporates new thermal blankets and new cooling provisions.
- Improved engine IP8 exhaust bleed screen (requires engine type design change).
- Improved thrust reverser blanket retention stud insulation.

Boeing also requests that, for up to six years from the date of granting, the exemption apply to any future product improvements or safety enhancements that might affect this same area of the thrust reverser.

Boeing has recently become aware that certain pneumatic duct failure conditions might not have been adequately addressed in the certification of the original 777 Rolls Royce thrust reverser inner wall type design. Duct failures at high altitude, low airplane speed, and low-engine-power conditions have recently been found critical for some aspects of the thrust reverser design on a different Boeing program. The design of the 777 Rolls-Royce thrust reverser assumed that high-engine-power pneumatic duct failure conditions were critical for the inner wall. Analysis is now underway to verify this assumption, but the analysis might not be complete in time to support the planned release of design improvements to address the unsafe conditions noted above. Consequently, Boeing also seeks exemption from §§ 25.901(c) and 25.1103(d) for aspects of compliance associated with the new burst duct failure condition described above.

Public interest

The Boeing petition states that a grant of the exemption is in the public interest for the following reasons:

"(a) It is in the interest of the public that airplane design improvements which improve safety are allowed to be implemented while additional improvements are being developed.

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[1] To see the entire petition, go to www.regulations.gov and search for FAA-2009-0320.

(b) The cost of continued repeat inspection of the blanket sealant and inner wall structure are significant. Implementing improvements as quickly as possible will reduce the financial impact and operational disruption to the operators."

Federal Register publication

A summary of the petition was published in the Federal Register on June 15, 2009 (74 FR 28322). No comments were received regarding the exemption request.

The FAA's analysis is as follows:

Background

FAA airworthiness directive (AD) 2005-07-24 was adopted in response to the in-service failures of the thrust reverser inner wall noted in the petitioner's request. This AD was intended to find damaged thrust reversers before the damage could result in a more severe failure condition; it did not correct the causes of thrust reverser inner wall damage. This exemption is an interim measure to permit approval of design improvements that increase safety by mitigating the known causes of thrust reverser inner wall thermal damage and bringing the affected airplanes closer to compliance with the applicable airworthiness standards. This exemption will remain in effect for six years unless superseded or rescinded.

The FAA's review of the Boeing letter dated March 31, 2009, raised certain questions, which Boeing answered in a letter dated May 12, 2009. In our review of the later letter, the question of whether the burst duct issue represented an unsafe condition was raised. Boeing submitted additional information in this regard, a summary of which has been placed in the docket via another Boeing letter, dated August 20, 2009.

Introduction

To obtain this exemption, the petitioner must show, as required by § 11.81(d), that granting the request is in the public interest, and, as required by § 11.81(e), that the exemption will not adversely affect safety or that a level of safety will be provided that is equal to that provided by the rules from which the exemption is sought.

This analysis will focus upon assuring that the design changes are in the public interest and do not adversely affect safety.

Effect on safety

The petitioner will be required by the conditions for granting this exemption to demonstrate that, for each applicable design change, there is no adverse effect on safety associated with granting this exemption. That is, the risks associated with the known non-compliance would not be increased by introduction of any design change(s) approved under this exemption.

In consideration of the above, the FAA concludes that granting this petition does not adversely affect safety.

Public interest

If the FAA were to deny this petition, that would have the effect of preventing implementation of product improvements that, while not resulting in a fully compliant product, would increase the level of safety and potentially reduce operating costs. The product improvements noted by the petitioner would mitigate the known causes of damage to the thrust reverser inner wall, bring the design closer to compliance with the applicable airworthiness standards, and potentially reduce the operating costs of the 225 affected Boeing Model 777 airplanes in service by reducing or eliminating the need for special repetitive inspections. Therefore, there is clearly a public benefit from granting this exemption.

In consideration of the above, the FAA concludes that granting this petition is in the public interest.

The FAA's decision

In consideration of the foregoing, I find that a partial grant of exemption is in the public interest and will not adversely affect safety. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, The Boeing Company is hereby granted an exemption from §§ 25.301, 25.303, 25.305, 25.307, 25.601, 25.603, 25.613, 25.901(b)(2) and (c), 25.1103(d), 25.1191, and 25.1301(d) for all 225 Rolls-Royce powered Boeing Model 777 airplanes, line numbers 1 through 796.

The petition is granted to the extent necessary to allow type certification of all type design changes after the date of this granting without a showing of compliance with the stipulated regulations as they relate to:

1. Pneumatic duct failures at high altitude, low airplane speed, and low-engine-power conditions; and

2. Thrust reverser inner wall overheat due to either hot air ingress behind the thermal blankets onto the thrust reverser inner wall, or engine intermediate pressure compressor 8th stage (IP8) stability bleed exhaust air impingement on the fan air flow side of the thrust reverser inner fan duct wall.

Conditions and limitations

The Boeing Company must demonstrate prior to an amended type certificate approval that the proposed design change:

1. does not increase the applied loads or reduce the structural capability in the areas covered by this exemption; and

2. does not have any adverse effect on the safety of the modified airplane compared to the unmodified airplane.